

CLAIMS

1. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein the powder has an average value of particle diameters not more than 3 micrometers.
- 15 2. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein powder having a particle diameter not more than 3 micrometers is mixed in the powder.
- 30 3. The electrode for discharge surface treatment according to claim 2, wherein the powder has a particle diameter varied in powder of an identical component.
4. The electrode for discharge surface treatment according to any one of claims 1 to 3, wherein the powder

contains any one of stellite, Ti-coated CBN, Tic+Ti, Cr₂C₃+Cr, Cr₂C₃+stellite, Al₂O₃+Ni, ZrO₂+Ni, and stellite+Co.

5. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein the powder has an aspherical shape.
- 15 6. The electrode for discharge surface treatment according to claim 5, wherein a shape of the powder is a scaly shape or a polyhedron shape.
- 20 7. The electrode for discharge surface treatment according to claim 6, wherein an average particle diameter of the powder is not more than 3 micrometers.
8. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the powder is obtained by mixing a small-diameter powder having a distribution of small particle diameters and a large-diameter powder having an average particle diameter twice or more as large as the small-diameter powder.

9. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the powder is obtained by mixing a small-diameter powder having a distribution of small particle diameters not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers.

10. The electrode for discharge surface treatment according to claim 8 or 9, wherein the small-diameter powder is metal powder refined by grinding.

11. The electrode for discharge surface treatment according to any one of claims 8 to 10, wherein the large-diameter powder has a substantially spherical shape.

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12. The electrode for discharge surface treatment according to any one of claims 8 to 11, wherein the powders to be mixed have an identical component.

13. The electrode for discharge surface treatment according to any one of claims 8 to 12, wherein the powder is any one of Co alloy, Ni alloy, and Fe alloy.

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14. The electrode for discharge surface treatment according to any one of claims 8 to 13, wherein the large-diameter powder is in 5 to 60 volume percent.

10 15. The electrode for discharge surface treatment according to any one of claims 8 to 13, wherein the large-diameter powder is in 5 to 20 volume percent.

15 16. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using 20 discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein 25 the powder has an average value of particle diameters not more than 1 micrometer.

30 17. An electrode for discharge surface treatment that is used for discharge surface treatment for causing, with a green compact obtained by compression-molding powder of metal, a metallic compound, or ceramics as an electrode, electric discharge between the electrode and a work piece in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film

consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

5 the powder contains a predetermined quantity or more of powder with an average value of particle diameters not more than 1 micrometer as the electrode material.

18. The electrode for discharge surface treatment according to claim 16 or 17, wherein the powder contains
10 any one of Co powder, Co alloy powder, Mo powder, Cr powder, W powder, Zr powder, Ta powder, Ti powder, V powder, and Nb powder.

19. A manufacturing method for an electrode for discharge
15 surface treatment, comprising:

a first step of grinding powder of metal, a metallic compound, or ceramics into aspheric powder having a predetermined particle diameter with a grinder; and

20 a second step of compress-molding the powder ground into a predetermined shape to have predetermined hardness.

20. The manufacturing method for an electrode for discharge surface treatment according to claim 19, wherein the grinder is a mill apparatus.

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21. The manufacturing method for an electrode for discharge surface treatment according to claim 20, wherein the mill apparatus is any one of a ball mill apparatus, a bead mill apparatus, a vibrating mill apparatus, and a jet
30 mill apparatus.

22. The manufacturing method for an electrode for discharge surface treatment according to claim 20 or 21,

wherein the mill apparatus includes a container and balls made of a same material as material of the powder to be ground.

5 23. The manufacturing method for an electrode for discharge surface treatment according to claim 20 or 21, wherein the mill apparatus includes a container and balls with surfaces thereof subjected to build up welding, plating, or thermal spraying using a same material as a 10 material of the powder to be ground.

24. The manufacturing method for an electrode for discharge surface treatment according to claim 20, wherein a material of the mill apparatus is ZrO_2 .

15 25. The manufacturing method for an electrode for discharge surface treatment according to any one of claims 19 to 24, wherein, in the first step, the predetermined particle diameter is not more than 3 micrometers.

20 26. A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece 25 in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein 30 the film is formed using an electrode obtained by compression-molding powder with an average value of particle diameters not more than 3 micrometers.

27. A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder containing metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece

5 in a machining fluid or in an air and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

10 the film is formed using an electrode obtained by compression-molding powder mixed with powder having a particle diameter not more than 3 micrometers.

28. A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder of metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance

15 generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

20 the film is formed using an electrode obtained by mixing a small-diameter powder having a distribution of small particle diameters and a large-diameter powder having

25 an average particle diameter twice or more as large as the small-diameter powder and compression-molding the powders.

29. A discharge surface treatment method of causing, with a green compact obtained by compression-molding powder of

30 metal or a metallic compound as an electrode, electric discharge between the electrode and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance

generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the film is formed using an electrode obtained by mixing a small-diameter powder having a distribution of

5 small particle diameters not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers and compression-molding the powders.

10 30. The discharge surface treatment method according to claims 28 or 29, wherein the small-diameter powder is powder refined by grinding.

15 31. The discharge surface treatment method according to any one of claims 28 to 30, wherein the large-diameter powder has a substantially spherical shape.

20 32. The discharge surface treatment method according to any one of claims 28 to 31, wherein the small-diameter particle and the large-diameter particle have an identical component.

25 33. The discharge surface treatment method according to any one of claims 28 to 32, wherein the powder is any one of Co alloy, Ni alloy, and Fe alloy.

34. The discharge surface treatment method according to any one of claims 28 to 33, wherein the large-diameter powder is in 5 to 60 volume percent.

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35. The discharge surface treatment method according to any one of claims 28 to 33, wherein the large-diameter powder is in 5 to 20 volume percent.

36. The discharge surface treatment method according to any one of claims 28 to 35, wherein

5 the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

10 37. The discharge surface treatment method according to any one of claims 28 to 36, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

15 38. A discharge surface treatment method of causing electric discharge between an electrode consisting of a green compact obtained by compression-molding powder with an average value of particle diameters not more than 1 micrometer and a work piece and forming, using discharge 20 energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece.

25 39. The discharge surface treatment method of causing electric discharge between an electrode consisting of a green compact obtained by compression-molding powder including a predetermined quantity or more of powder with an average value of particle diameters not more than 1 30 micrometer and a work piece and forming, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a

surface of the work piece.

40. The discharge surface treatment method according to any one of claims 38 to 39, wherein

5 the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

10 41. The discharge surface treatment method according to any one of claims 38 to 39, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

15 42. The discharge surface treatment method according to any one of claims 38 to 41, wherein the powder is powder of metal, a metal compound, or ceramics.

20 43. A discharge surface treatment apparatus that has an electrode consisting of a green compact obtained by compression-molding powder containing metal or a metallic compound and a work piece on which a film is formed, the electrode and the work piece being arranged in a machining fluid or in an air, generates a pulse-like electric discharge between the electrode and the work piece using a power supply apparatus electrically connected to the electrode and the work piece, and forms, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the electrode is manufactured by compression-molding

powder having an average value of particle diameters not more than 3 micrometers.

44. A discharge surface treatment apparatus that has an
5 electrode consisting of a green compact obtained by compression-molding powder containing metal or a metallic compound and a work piece on which a film is formed, the electrode and the work piece being arranged in a machining fluid or in an air, generates a pulse-like electric
10 discharge between the electrode and the work piece using a power supply apparatus electrically connected to the electrode and the work piece, and forms, using discharge energy of the electric discharge, a film consisting of an electrode material or a substance generated by reaction of
15 the electrode material due to the discharge energy on a surface of the work piece, wherein

the electrode is manufactured by compression-molding powder mixed with powder having a particle diameter not more than 3 micrometers.

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45. A discharge surface treatment apparatus comprising:
an electrode consisting of a green compact obtained by compression-molding powder of metal or a metal compound;
a work piece on which a film is formed; and
25 a power supply apparatus electrically connected to the electrode and the work piece,
the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the work piece with the power supply apparatus and forming,
30 using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein

the electrode is manufactured by compression-molding powder obtained by mixing a small-diameter powder having a distribution of small particles and a large-diameter powder having an average particle diameter twice or more as large 5 as the small-diameter powder.

46. A discharge surface treatment apparatus comprising:
an electrode consisting of a green compact obtained by compression-molding powder of metal or a metal compound;
10 a work piece on which a film is formed; and
a power supply apparatus electrically connected to the electrode and the work piece,

the discharge surface treatment apparatus generating pulse-like electric discharge between the electrode and the 15 work piece with the power supply apparatus and forming, using discharge energy of the discharge, a film consisting of an electrode material or a substance generated by reaction of the electrode material due to the discharge energy on a surface of the work piece, wherein
20 the electrode is manufactured by compression-molding powder obtained by mixing a small-diameter powder having a distribution of small particles not more than 3 micrometers and a large-diameter powder having an average particle diameter not less than 5 micrometers.

25 47. The discharge surface treatment apparatus according to claims 45 or 46, wherein the small-diameter powder is powder refined by grinding.

30 48. The discharge surface treatment apparatus according to any one of claims 45 to 47, wherein the large-diameter powder has a substantially spherical shape.

49. The discharge surface treatment apparatus according to any one of claims 45 to 48, wherein the small-diameter particle and the large-diameter particle have an identical component.

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50. The discharge surface treatment apparatus according to any one of claims 45 to 49, wherein the powder is any one of Co alloy, Ni alloy, and Fe alloy.

10 51. The discharge surface treatment apparatus according to any one of claims 45 to 40, wherein the large-diameter powder is in 5 to 60 volume percent.

15 52. The discharge surface treatment apparatus according to any one of claims 45 to 50, wherein the large-diameter powder is in 5 to 20 volume percent.

53. The discharge surface treatment apparatus according to any one of claims 45 to 52, wherein

20 the electrode and the work piece are arranged in a machining fluid or a predetermined gas atmosphere, and electric discharge is performed in the machining fluid or the predetermined gas atmosphere.

25 54. The discharge surface treatment apparatus according to any one of claims 45 to 53, wherein a pulse current with a discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

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55. A discharge surface treatment apparatus comprising: an electrode consisting of a green compact obtained by compression-molding powder with an average value of

particle diameters not more than 1 micrometer;
a work piece on which a film is formed; and
a power supply apparatus electrically connected to the
electrode and the work piece,

5 the discharge surface treatment apparatus generating
pulse-like electric discharge between the electrode and the
work piece with the power supply apparatus and forming,
using discharge energy of the discharge, a film consisting
of an electrode material or a substance generated by
10 reaction of the electrode material due to the discharge
energy on a surface of the work piece.

56. A discharge surface treatment apparatus comprising:
an electrode consisting of a green compact obtained by
15 compression-molding powder containing a predetermined
quality or more of powder with an average value of particle
diameters not more than 1 micrometer;

20 a work piece on which a film is formed; and
a power supply apparatus electrically connected to the
electrode and the work piece,

the discharge surface treatment apparatus generating
pulse-like electric discharge between the electrode and the
work piece with the power supply apparatus and forming,
using discharge energy of the discharge, a film consisting
25 of an electrode material or a substance generated by
reaction of the electrode material due to the discharge
energy on a surface of the work piece.

57. The discharge surface treatment apparatus according to
30 any one of claims 55 to 56, wherein

the electrode and the work piece are arranged in a
machining fluid or a predetermined gas atmosphere, and
electric discharge is performed in the machining fluid

or the predetermined gas atmosphere.

58. The discharge surface treatment apparatus according to any one of claims 55 to 56, wherein a pulse current with a 5 discharge pulse width not more than 70 microseconds and a peak current value not more than 30 amperes is supplied between the electrode and the work piece.

59. The discharge surface treatment method according to 10 any one of claims 55 to 56, wherein the powder is powder of metal, a metal compound, or ceramics.